Interdisciplinary perspectives on particle physics

On 23–30 July 2018, physicists joined forces with researchers from the humanities in Wuppertal, Germany. The event, the third in a series of spring and summer schools, was organized by the research unit The Epistemology of the Large Hadron Collider (ELHC), led by the German Research Foundation and the Austrian Science Fund, with additional support from the University of Wuppertal. ELHC is an international collaboration between physicists, philosophers, historians and sociologists that aims for a comprehensive understanding of the goals and methods of LHC research. The unit has been active for approximately two years and follows the lead of three earlier projects at Wuppertal conducted between 2009 and 2015.

Discussions focussed on the theme “Particle physics at the crossroads”, with no residence of physics beyond the Standard Model from the LHC, where particle physics is headed? While these challenges are first and foremost being addressed by physicists, historians and social scientists can help identify the outstanding scientific and ethical concerns that arise from social organisation. The talks at this year’s summer school reviewed all examples of close work between the humanities and social sciences has a bearing on current issues in high-energy physics. Kent Stanley, a philosopher from St. Louis University in the US, analysed the statistical reasoning involved in LHC research, arguing that conceptions of conventional knowledge claims can explain why the practice of high-energy physics relies more on Bayes and Faraday that demonstrated the complexity of the underlying data and established the existence of new particles such as the Higgs boson. This programme was complemented by three inside views from physics: John Ellis from King’s College, London, reported on recent progress at CERN on his view of future theoretical developments; former CERN Director-General Rolf-Dieter Heuer provided insights into the factors driving particle-physics research; and ATLAS member Christian Zollner from Wuppertal University, as well as Margrethe Møllbyri from the Beckurts Institute of Technology, gave introductory lectures on event reconstruction and theory, respectively.

At the end of the school, the discussions returned to the central theme of “particle physics at the crossroads”, and it is likely that many of them will be key to characterising the current situation. One may feel reminded of the situation in the 1980s where a “zoo” of particles was discovered without any hint, at least at first, of what theoretical structures underpinned them. However, the current situation is rather different because it is precisely such hopes for discovering particles beyond the current theory that have been dashed by the LHC so far.

The responses of the participants were positive, noting the importance and complementarity of the methods discussed. The participants agreed that bringing together physicists, philosophers, historians and sociologists was fruitful and less hampered by contingency than one might have expected. As the so-called science wars have highlighted, there is an open mind on all sides to facilitate a fruitful discussion between the natural sciences, the social sciences and the humanities. The future of particle physics may be uncertain, but collaborative efforts such as the Wuppertal summer school will certainly contribute to a better assessment of the aims and relevance of this field of fundamental physics research.

Florian Sorge (KIT) as chair, University of Wuppertal and Adrian Wültzich Technical University Berlin.

The future of deep-inelastic scattering

The most recent edition of the International Workshop on Deep Inelastic Scattering and Related Subjects (DIS2018) was held in Kobe, Japan, on 6–10 April 2018. The event continued in the style of a workshop, with almost 230 talks presenting new results on all things hadron physics: spin and structure functions, parton densities, and quantum chromodynamics (QCD) studies for high-sensitivity electron–proton (e+p) scattering, and heavy-ion physics.

The DIS2018 organising committee.

Yuji Yamazaki

Yuji Yamazaki

Wuppertal Summer School Interdisciplinary perspectives on particle physics

The vast range of physics covered in DIS workshops cannot be easily integrated into a single theoretical framework, and there are slightly different views on valence interactions depending on the type and energy of the underlying collisions. One view, which applies to high-energy collisions, is a combined fit of one-momentum partners with little transverse momentum, and high energy-recovery linac, would provide, up to 60 GeV through a dedicated energy–recovery linac, would provide, in addition to precise measurements in the Higgs sector, more information on hadron structure through electron–positron and electron–ion collisions in regimes of low and very high Q^2. LHeC would also allow researchers to see, through the behaviour of total and differential cross sections in the high-energy limit, if there is any saturation in the parton evolution inside nucleons and nuclei. Further down the line, the Future Circular Collider hadron–electron (FCC–he) project at CERN, as well as the proposed very-high-energy electron–proton (VHEeP) collider at the Brookhaven National Laboratory or Jefferson Lab in the US, at centre–of–mass energies up to 100 TeV (October 2018), will offer not only a detailed holographic view of the space and spin structure of quarks and gluons inside hadrons, but also thanks to its very high luminosity, high-precision probes of particles that carry high-momentum fraction of the parent hadron.

Evolution

Meanwhile, the proposed Large Hadron electron Collider (LHeC) at CERN, bringing protein beams from the LHC into collisions with electrons accelerated up to 60 GeV through a dedicated energy–recovery linac, would provide, in addition to precise measurements in the Higgs sector, more information on hadron structure through electron–positron and electron–ion collisions in regimes of low and very high Q^2. LHeC would also allow researchers to see, through the behaviour of total and differential cross sections in the high-energy limit, if there is any saturation in the parton evolution inside nucleons and nuclei. Further down the line, the Future Circular Collider hadron–electron (FCC–he) project at CERN, as well as the proposed very-high-energy electron–proton (VHEeP) collider at the Brookhaven National Laboratory or Jefferson Lab in the US, at centre–of–mass energies up to 100 TeV (October 2018), will offer not only a detailed holographic view of the space and spin structure of quarks and gluons inside hadrons, but also thanks to its very high luminosity, high-precision probes of particles that carry high-momentum fraction of the parent hadron.

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Russian accelerator science in focus

The 28th Russian Particle Accelerator conference, RUPAC2018, was convened on 1–5 October 2018 in Protvino, Russia, at the Institute of Nuclear Physics of the Russian Academy of Sciences. This year’s conference reviewed the NRC KI–IHEP under the auspices of the Nuclear Physics (BINP), the Joint Institute for Nuclear Research (JINR), and the NRC KI, which has undergone a name change to the Russian Academy of Sciences.

The 150 talks and 15 poster contributions featured both national and international accelerator facilities, but attention was directed at Russia’s domestic machine. BINP is being considered for the VEPP-2000 and VEPP-4 electron–positron colliders, the operation of which is expected to begin in 2021, according to R. Tomé from BINP.

The bulk of reports from JINR in Dubna were devoted to progress in the Nucleon–based Collider Facility (NLCF) project at the nucleon facility. Significant progress was also reported for the heavy-atomic collision of the HERA B low-energy electron-positron collider (LEP). The status of, and plans for, the other domestic accelerator facilities — the high-intensity proton linear accelerator at INR (Silov), the synchrotron radiation (SR) complex SR–B at NRC KI (Moscow), and the Ioffe synchrotron synchrotron SC–1000 at NRC KI–PMI (Gatchina) — were also presented. Attention was also given to new SR projects: the Siberian Circular Photon Source (SKPF) and the fourth-generation Specialized Synchrotron Radiation Source 4.

In the first stream of the workshop, the implications of LHCb’s results and the unique potential of LHCb’s forward acceptance to deconvolve the proton target distribution functions in the unmeasured QCD regimes of low and high longitudinal momentum fraction x were discussed, as were a variety of models with the distinctive signature of displaced heavy neutral lepton decay modes that could explain neutrino oscillations and non-zero neutrino masses. Presentations also focused on the full multi-dimension of charm (c) stated accessible to LHCb beyond the (p, from the (0, to x, Y and Z states. Future measures were on extracting the implications of LHCb beyond the J/ψ, and hoped that this valuable overlap of theory and experiment would surely be a hot topic.

The workshop was a welcome opportunity to consider what will be possible with LHCb’s planned upgrades. The workshop was capped by a theory keynote talk by Antonio Fich from Valencia, which addressed current trends between the Standard Model (SM) and recent results in flavour physics.

The physics content of the workshop was divided into four streams. The first was on mixing and CP violation in beauty and charm hadrons, looking at non-leptonic decays. A major focus was on extracting the y parameter of the Cabibbo–Kobayashi–Maskawa quark–mixing matrix and the B– and CP asymmetries, with experimental and theoretical updates presented. Measurements of B-meson mixing that are especially important in constraining physics beyond the SM, and improved inputs from lattice quantum chromodynamics (QCD) calculations are crucial to this endeavour. Part of the open session was dedicated to the decays B → η → ρπ, which is one of the most important in B physics, and B → K∗γ, which are added (B → K∗γ) measurements are crucial to this endeavour. Part of the open session was dedicated to the decays B → η → ρπ, which is one of the most important in B physics, and B → K∗γ, which are added (B → K∗γ) measurements are crucial to this endeavour. 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Users highlight successful campaigns

On 5–7 December 2018, the annual ISOLDE Workshop and Users meeting took place at CERN, attracting 153 participants. The programme consisted of four presentations, of which 22 were invited talks and 19 were oral contributions selected from 74 submitted abstracts.

ISOLDE, CERN’s long-running nuclear research facility, directs a high-intensity proton beam from the Proton Synchrotron Booster (PSB) at a target station to produce a range of isotopes. Different devices are used to extract, isolate, and separate the isotopes according to their mass, forming low-energy beams that are delivered to various experiments. These radioactive ion beams (RIBs) can also be re-accelerated using the HIE-ISOLDE linear accelerators (Linacs). An energy upgrade of the HIE–ISOLDE superconducting linac was completed this year, enabling RIBs with an energy up to about 10 MeV per nucleon.

A focus of the 2018 ISOLDE workshop concerned beam upgrades and consolidation efforts during the second long shutdown of CERN’s accelerator complex (LS2), including replacing 10-year-old equipment and adding more beam-monitoring systems. Five sessions were devoted to overview talks from ISOLDE users on the outcomes of physics campaigns at the different experimental set-ups, two sessions discussed progress at other RIB facilities in the world, and one session focused on applications in life sciences with an emphasis on the CERN MEDIS programme.

The meeting began with an overview of successful experimental campaigns at the HIE–ISOLDE RIB accelerator, with operational set-ups achieved at all three beam lines. A total of 17 different RIBs were accelerated during July–November 2018. Beams of isotopes with an atomic mass from 71 to 228, with the radius–228 beam being the heaviest ever accelerated at ISOLDE, were delivered. The HIE–ISOLDE campaign began with seven experiments at the first beam line, with the MINIBALL detector array and its ancillary detectors. In October, two experiments used the new ISOLDE sole-nucleon spectrometer at the second beamline for the first time, with an inner detector from Argonne National Laboratory. For these, the full accelerator capacity was used for the first time. At the third beam line, used for “traveling experiments”, those experiments used the scattering chamber – a large vacuum chamber that can hold several combinations of particle detectors brought by the users; one experiment used an optical time projection chamber to look for very rare proton decays from the halo nucleus beryllium-7. The last experiment was performed in the scattering chamber, after protons decays from the halo nucleus beryllium-7. And radioactive tin-132 was also measured in this facility.

Prize winners

The workshop organized by Gerda Neyens (second from right) with Victoria Pollet, for the best poster, and Yago de Lemos Leon and Jan Abernethy (left and right of Neyens), who received the best young speaker.

The LHC lies dormant, its superconducting magnets drained of liquid helium to be brought back to room temperature. Along with the rest of CERN’s accelerator complex, the LHC entered long-shutdown two (LS2) on 10 December.

The features in this first issue of 2019 bring you all the shutdown news from the seven LHC experiments, and what to expect when the souped-up detectors come back online in 2021.

CERN–Austria Silver celebration for student programme

Student success

Golding the CERN–Austria PhD programme in November

The programme has trained nearly 200 students in the stimulating environment off CERN. The bulk of these were in the fields of accelerator and detector research, with information technology and electronics also featuring large. Statistics from the programme show that, in the medium term, one third of all programme participants return to CERN or work in other European countries. Working in a cross-disciplinary and multicultural research environment such as CERN, participants learn how to collaborate in international networks, are exposed to leading-edge technologies and fine-tune their language skills. The Austrian ambassador, Elisabeth Tichy-Fisslberger, who participated in the celebration, underlined that the programme has also helped strengthen broader links between CERN and Austria, allowing significant technology transfer and networking with Austrian universities and high-tech industries.

CERN–Austria PhD programme serves as a model of efficient collaboration between CERN and its member states, and has inspired similar initiatives from other countries.

Michael Benedikt CERN